



# Dealing with Algal Blooms: Time to Make a Plan

# **Guidance for Developing an Algal Bloom Management and Response Plan**

331-654 • 8/31/2020







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### **Glossary**

**Anatoxin-a**: Nerve toxin produced by a number of cyanobacteria.

**Biovolume**: The volume of cells in a unit amount of water (mm<sup>3</sup>/L). Biovolume is estimated using a digitized microscope to determine the relative abundance of phytoplankton of varying shapes and sizes.

**Chlorophyll-a**: Photosynthetic green pigment contained in algae and cyanobacteria that is essential for producing energy from light. Can be used to estimate the amount of cyanobacteria in a sample. (See phycocyanin)

**Congener**: One of a class of compounds with similar structures and similar chemical properties. For example, the class of chemicals called microcystins has over 140 congeners.

**Cyanobacteria**: Type of bacteria with qualities similar to algae and other plants. They are phototrophic and occur naturally in freshwater lakes, ponds, and river impoundments.

**Cyanotoxins**: Chemical compounds produced by some species of cyanobacteria that pose serious public health risks if found in drinking water sources.

**Cylindrospermopsin**: Liver toxin produced by a number of cyanobacteria.

**Detection**: A result greater than or equal to the method reporting limit.

**Diatoms**: Single-celled algae. Most diatoms are photosynthetic.

**ELISA**: Enzyme linked immunosorbent assay (ELISA) is a three step method of cyanotoxin analysis commonly used to detect total microcystins, cylindrospermopsin and anatoxin-a. It is more rapid and less expensive than LC/MS/MS. It is not congener specific and can produce a false positive result in the presence of degraded cyanotoxin.

**Eutrophic**: Rich in nutrients supporting a dense plant population, especially algae.

**Extracellular**: Located or occurring outside of the cell or cells.

**Fluorescence**: Property of chlorophyll-a and phycocyanin in which they absorb light at a shorter wavelength and re-emit light at a longer wavelength.

Genus: Taxonomic category used in biology that ranks above species and below family.

**Geosmin**: Naturally occurring compound produced by cyanobacteria and other bacteria. It gives water an earthy or musty smell and is a frequent source of taste and odor complaints.

HAB: Harmful algal bloom.

**Intracellular**: Located or occurring inside of the cell or cells.

**LC/MS/MS**: Liquid chromatography with tandem mass spectrometer, also called "LC tandem mass spec." Sample is first run through a chromatography column that separates the constituents by time. Then the column effluent is run through a mass spectrometer that separates the constituents by mass and fragmentation pattern. Available for cylindrospermopsin, anatoxin-a, saxitoxin, and some (but not all) microcystin congeners (EPA Method 544).

Lyse: To rupture an organism's cell wall, releasing any toxins that may be present inside the cell.

**MIB**: Two-methylisoborneol (MIB), a naturally occurring compound produced by cyanobacteria and other bacteria. It gives water an earthy or musty smell and is a frequent source of taste and odor complaints.

**Microcystins**: Liver toxins produced by a number of cyanobacteria. Total microcystins are the sum of all the variants/congeners of the cyanotoxins microcystin.

**NOM**: Natural organic matter.

Oligotrophic: Low in plant nutrients and usually containing abundant dissolved oxygen.

**Oxidant**: A chemical that has the ability to oxidize other substances by accepting their electrons. Common oxidants in water treatment are chlorine, chlorine dioxide, ozone and potassium permangate.

**Photosynthetic**: Relating to the process by which organisms use sunlight to synthesize nutrients from carbon dioxide and water.

**Phototroph**: An organism that obtains energy from sunlight to synthesize organic compounds for nutrition.

**Phycocyanin**: (Fī-kō-'**sī**-ə-nən) a blue photosynthetic pigment contained in cyanobacteria, but not algae. Can be used to estimate the amount of cyanobacteria in a sample.

**Phytoplankton**: (Fī-tō-**plank**-tən) microscopic photosynthetic organisms that live in watery environments, both salty and fresh. This includes cyanobacteria as well as photosynthetic diatoms and other microscopic algae.

**Pre-oxidation**: In water treatment, to add an oxidant before other processes, usually filtration.

**qPCR**: Quantitative polymerase chain reaction. A technology used to target a genetic sequence associated with a specific cyanotoxin and quantify the presence of that toxin in a sample.

**Saxitoxins**: Nerve toxins produced by a number of cyanobacteria.

**SUVA**: Specific ultraviolet adsorption is the absorbance of ultraviolet light in a water sample at a specific wavelength. It is used to characterize natural organic matter (NOM) in a water sample and to determine disinfection by-product (DBP) formation potential.

#### 1.0 Introduction

In August 2014 an algal bloom in Lake Erie resulted in a "do not drink" advisory for nearly 500,000 people in and around Toledo, Ohio (Carpenter, 2020). Four years later, a bloom in the drinking water source for Salem, Oregon led to a similar advisory (Salem, 2018). Harmful algal blooms (HABs) are a potential source of contamination for surface water sources in Washington. Toxins produced by cyanobacteria found in source water or released from cyanobacterial cells through treatment processes can harm people. By damaging the liver, nervous system, skin, and gastrointestinal systems cyanotoxins can cause paralysis, organ damage, heart failure, and death.

In addition to potential public health risks of cyanobacteria, any source water algal bloom can cause:

- Increased raw water turbidity.
- Increased filter loading and shorter filter run times.
- Reduced treatment plant capacity through clogging of intakes, screens, and filters.
- Increased disinfection byproduct precursors.
- Increased operational costs.
- Odor, taste, and color problems in finished water.
- Loss of consumer confidence in the quality of drinking water.

Systems can prepare for and mitigate these events by proactive planning and active source management. Public water systems using surface water are vulnerable to HABs and should develop an Algal Bloom Management and Response Plan (Algal Plan). Having procedures in place can prevent harmful levels of cyanotoxins from reaching the distribution system, avoid treatment disruptions, and maintain your customers' confidence in their drinking water supply.

This document provides guidelines, important information, and references needed to develop an Algal Plan. It includes a protocol for monitoring, sampling, and analysis of source, raw, and finished water. Drinking water health advisory levels for finished water from the Environmental Protection Agency (EPA) for two cyanotoxins (Microcystins and Cylindrospermopsin) are presented, along with health guidance values for anatoxin-a from other state health agencies.

#### What are Cyanobacteria?

Cyanobacteria, sometimes called "blue-green algae," are a type of bacteria with qualities similar to algae and other plants. They occur naturally in freshwater lakes, ponds, and river impoundments. They are phototrophic (use sunlight as their primary energy source). Cyanobacteria can adjust their buoyancy throughout the day. By moving up and down through the water column they find sunlight at the surface and nutrients in deeper layers. When the amount of sunlight, temperature, and nutrients are adequate they can reproduce rapidly.

Cyanobacteria and algae found in the water column of lakes and ponds are part of a group of phototrophic microorganisms called phytoplankton. Unique among the phytoplankton, Cyanobacteria can convert inert atmospheric nitrogen into an organic form usable for growth. This ability to fix nitrogen means blooms often occur in later summer, months after nitrogen has been diminished from the water column from phytoplankton uptake.

#### What is a Harmful Algal Bloom?

An algal bloom is a sudden increase in the rate of growth or accumulation of phototrophic organisms. In this document, the term algal bloom includes both algae and cyanobacteria. Blooms occur naturally in lakes, reservoirs, ponds, and slow-flowing rivers. A bloom is most likely to occur during sunny, calm weather when high nutrient concentrations (particularly phosphorus) are present in water. Not all algal blooms are harmful. However, blooms have potential to become harmful due to their impacts on treatment processes, creation of taste and odor compounds, and production of cyanotoxins by some species of cyanobacteria.

#### What are Cyanobacterial Toxins?

There are approximately three thousand known species of cyanobacteria. Over fifty species are identified as capable of producing chemical compounds that pose serious public health risks if found in drinking water sources. These chemical compounds are called cyanobacterial toxins or cyanotoxins. During some blooms cyanotoxins may be released directly into the water source (extracellular) or be contained within the cyanobacteria cells (intracellular). Cyanotoxins can harm people and animals when present in high enough concentrations. They may cause health effects such as skin rashes and lesions, vomiting, gastroenteritis, headaches, and eye, ear, and throat irritations. More severe symptoms affect the liver or nervous system.

This document focuses on the four currently most common cyanotoxins: microcystin, cylindrospermopsin, anatoxin-a, and saxitoxin. Other cyanotoxins exist; we will expand this document as we learn and discover more. The following cyanotoxin descriptions are taken from *Managing Cyanotoxins in Drinking Water: A Technical Guidance Manual for Drinking Water Professionals* (AWWA, WRF 2016) and *Guidelines for Drinking Water Quality, Fourth Edition*. (WHO 2017). The references and resources listed at the end of this document have further information.

#### Microcystins

Microcystins are the most common and heavily-researched group of cyanotoxins. Microcystin-LR is the most common of the many variants (compounds with similar structure). Microcystins can be produced by *Dolichospermum (Anabaena), Microcystis, Oscillatoria, Planktothrix, Nostoc*, and *Anabaenopsis* species. More than one type of microcystin may occur in a particular cyanobacteria strain. Microcystins are hepatotoxins (damage the liver). A lethal dose causes death in vertebrates by liver necrosis within hours or up to a few days.

Noticeable symptoms occur only in severe cases. This means that liver injury from a non-lethal dose is likely to go unnoticed. Some studies show that microcystin toxicity is cumulative. Researchers suspect microcystins are liver carcinogens, which could increase cancer risk to humans following continuous, low level exposure.

Unlike other cyanotoxins, microcystins are commonly bound within the cell and only released into water when the cell ruptures, or lyses. When released, microcystins are stable in water and can linger for months.

#### Cylindrospermopsin

Cylindrospermopsin is a cyanotoxin most commonly found in the southern United States. It is water-soluble in the typical pH range of natural waters. It can damage the liver, kidneys, blood cells, and cellular DNA. Cylindrospermopsin has three known variants: CYL, 7-epiCYL, and deoxyCYL.

#### Anatoxin-a

Anatoxin-a is a potent neurotoxin (attacks the nervous system) and the smallest of the cyanotoxins. It is one of three neurotoxic alkaloids isolated from cyanobacteria, produced by various species of cyanobacteria including *Dolichospermum* (*Anabaena*), *Planktothrix*, *Oscillatoria*, *Aphanizomenon*, *Cylindrospermum*, and *Microcystis*. Anatoxin-a was first detected in Canada in the 1960s. Since then, there have been reports of cattle, elk, cat, and dog poisonings.

Algal cells retain anatoxin-a in favorable growth conditions. However, cells release toxin into the gastrointestinal tract if an animal consumes water containing these algal cells. Therefore, pets that lick scum from their fur are at highest risk from anatoxin-a exposure. Ingestion of a sub-lethal dose of these neurotoxins leaves no chronic effects and recovery appears to be complete. Anatoxin-a has only one additional reported variant, homoanatoxin-a. Anatoxin-a is typically found in its cationic form in natural waters. It degrades to nontoxic products in sunlight and at a high pH (8-9).

#### Saxitoxin

Saxitoxin is another potent neurotoxin with properties similar to anatoxin-a. Sixteen confirmed saxitoxins have been reported from cyanobacterial samples. Saxitoxins were originally isolated from shellfish, where they are the main cause of paralytic shellfish poisoning. In fresh water saxitoxin is produced by *Aphanizomenon, Dolichospermum (Anabaena), Lyngbya, and Cylindrospermopsis*.

Since EPA is not currently considering saxitoxin for future regulation, less information is available on drinking water health effects and treatment effectiveness. For these reasons, saxitoxin is covered only briefly in this document.

#### What is a Health Advisory Level (HAL)?

The Safe Drinking Water Act gives EPA authority to publish health advisories for contaminants not subject to any national primary drinking water regulation. EPA assesses the latest peer-reviewed science to provide information on the health risks of these chemicals. This allows water system operators, and state, tribal, and local officials who have primary responsibility for overseeing these systems, to take appropriate actions to protect their residents. HALs serve as informal technical guidance for health effects information and methods to sample and treat these non-regulated contaminants in drinking water. HALs are not legally enforceable federal standards and are subject to change as new information becomes available (USEPA 2015a).

#### Health Advisory Levels for Microcystins, Cylindrospermopsin and Anatoxin-a

Microcystins, cylindrospermopsin, anatoxin-a, and saxitoxin have been found in Washington water bodies. Recreational guidelines have been established and are briefly discussed in section 4.0. There are no state drinking water regulatory limits for cyanotoxins and no immediate plans to develop them.

EPA included ten cyanotoxin variants in the Fourth Unregulated Contaminant Monitoring Rule (UCMR4). The UCMR4 requires selected systems to monitor for these unregulated contaminants. This was a step toward establishing future regulatory limits in drinking water for these contaminants (NHDES 2016).

EPA established ten-day HALs for total microcystins and cylindrospermopsin (USEPA, 2015b and 2015c). The HALs give concentrations at or below which no adverse human health effects would be expected for up to ten days of exposure. HALs for microcystin and cylindrospermopsin are given for two separate population groups. The first group includes infants, pre-school children under six years, and susceptible adults

(pregnant women, nursing mothers, elderly, immune-compromised, and dialysis patients). These HALs are shown in Table 1 below. The second group includes school-aged children (six years and older) and other adults. The HALs for both groups are in Appendix E.

Table 1: EPA Cyanotoxin Health Advisory Levels for Vulnerable People\*

| Cyanotoxin         | Cyanotoxin level (μg/L) |
|--------------------|-------------------------|
| Total microcystins | 0.3                     |
| Cylindrospermopsin | 0.7                     |

<sup>\*</sup>Infants, pre-school children, susceptible adults (pregnant women, nursing mothers, elderly, immune-compromised, and dialysis patients).

The Department of Health (DOH) recommends that public water systems use the lower EPA HALs for infants, pre-school children, and susceptible adults for total microcystins and cylindrospermopsin in drinking water as thresholds to trigger proactive utility actions. Proactive steps could include increased monitoring, changes in treatment strategies, and use of alternative sources.

If a system exceeds EPA HALs for total microcystin or cylindrospermopsin in treated drinking water the utility should provide a "do not drink" advisory to their customers, as cyanotoxins are not destroyed by boiling. More details are in Section 3.4 and Appendix E. Coordinate public notification with the Office of Drinking Water (ODW).

EPA has not established HALs for anatoxin-a or saxitoxin.

Some other states, including Ohio (Ohio EPA, 2020), Minnesota (MDH, 2016), and Vermont (VDH, 2015) have established drinking water health guidance values for anatoxin-a. These advisory levels range from 0.1 to 0.5  $\mu$ g/L. Ohio, a state with extensive experience with HABs in drinking water, recently updated its anatoxin-a health threshold level for vulnerable people to 0.3  $\mu$ g/L (OhioEPA, 2020). ODW supports the use of Ohio's health threshold level as an appropriate trigger for increased monitoring, changes in treatment strategies, and use of alternative sources.

#### Saxitoxin and other cyanotoxins

EPA did not list saxitoxin for future regulation and did not develop supporting health effects documentation for it. Ohio is the only state with an established saxitoxin drinking water health threshold,  $0.3 \mu g/L$  (OhioEPA, 2020). Due to the limited information available and infrequent occurrence of saxitoxin in our state, we cannot recommend a specific trigger value for saxitoxin.

Other cyanotoxins exist and new ones are being discovered. If you detect cyanotoxins in raw water other than the four compounds discussed above, follow the treatment and finished water monitoring guidelines recommended in this document.

#### Will My Treatment Plant Remove Algae and Cyanotoxins?

Treatment effectiveness for cyanotoxins varies depending upon the type of toxin, whether it is intracellular (inside the cell) or extracellular (outside the cell), and specifics of the treatment processes in your treatment plant. Appendix A1 gives an overview of common treatment strategies and effectiveness of specific treatment processes. The resource section at the end of this document lists additional sources of information.

USEPA provides an overview of treatment strategies to remove algae and remove or oxidize cyanotoxins found in raw water in *Recommendations for Systems to Manage Cyanotoxins in Drinking Water* (USEPA,

2015a). It provides more detailed cyanotoxin treatment information in *Water Treatment Optimization for Cyanotoxins* (Version 1.0) (USEPA, 2016). Oregon Health Authority (OHA, 2019) summarized and expanded EPA guidance to include filtration technologies common in the Pacific Northwest, including slow sand, bag/cartridge, and membrane filtration.

#### 2.0 Vulnerability of Your Surface Water Source to HABs

All water systems using surface water sources can be impacted by HABs, even if algal blooms have not yet occurred. Water systems should evaluate the risk for each surface water/GWI source based on history of blooms, lake stratification and turn-over patterns, and water quality parameters. Even systems with cold, low-nutrient source water should enact some level of bloom surveillance. We encourage all water systems to collect at least some of the water quality parameters listed below to build a baseline of information that will help guide both ongoing management and response efforts.

Appendix A2 lists public water systems with surface water sources that have experienced algal blooms or are potentially at risk because their source is a lake or impoundment, or downstream from one. Systems with flowing sources (rivers or creeks) are not generally included, but may still be vulnerable if the water source is slow moving or treatment basins are uncovered and in direct sunlight.

Appendix A3 lists Washington state water bodies that serve as public drinking water sources in which the presence of cyanotoxins has previously been confirmed. This information is from the Department of Ecology's Fresh Water Monitoring Program. No statewide sampling program was conducted, so this list is by no means a comprehensive assessment of our region's source waters. Appendix A3 also does not include sources used by private individuals for single family homes. Complete results are at <a href="https://nwto.com/nwto

When evaluating risk, there are many water quality parameters that can be used (see section 3.2). Some are simple, others are complex.

- Presence of blooms and scums on water.
- Fish kills due to hypoxia (low oxygen levels).
- Secchi disc depth in source water reservoirs/lakes.
- Dissolved oxygen levels and temperature stratification (historical patterns/potential).
- Presence of taste and odor causing compounds (for example, MIB and geosmin).
- Nitrogen and phosphorus levels.
- Cyanobacterial cell counts and dominant cyanobacterial species.
- Phytoplankton cell counts.
- Levels of Chlorophyll-a (green photosynthetic pigment present in algae, cyanobacteria and plants).
- Levels of Phycocyanin (blue photosynthetic pigment present in cyanobacteria).

In addition, Section 3.2 discusses plant performance measures that can give an indication of phytoplankton blooms. These can include a marked decrease in filter run times and increases in coagulant dose or chlorine demand.

Historical water quality information for larger water bodies may be found in at <u>sourcewatercollaborative.org/assess-protect-drinking-water-sources/find-data-in-my-area</u>. Other useful resources include Source Water Assessments and Lake Management Plans, as well as Clean Water Act 303(d) and 305(b) Integrated Reports.

### 3.0 Algal Bloom Management and Response Plan

If a surface water source is vulnerable, the system should develop an Algal Bloom Management and Response Plan (Algal Plan) to establish strategies for monitoring and responding to HABs in the source water. The plan guides managers and operators on effective source, raw, and finished water monitoring and treatment adjustments to prevent cyanotoxins from reaching the distribution system. In this document, source water monitoring refers to samples collected from various locations in the lake or other waterbody, especially in the intake vicinity. Raw water monitoring refers to samples collected directly from the water treatment plant intake before any treatment processes. Finished water monitoring refers to samples collected from the distribution entry point, downstream from all treatment processes, including disinfection.

Suggested elements to include in your Algal Plan are outlined below, along with resources, examples, and links for further research. A suggested algal bloom response flowchart is in Figure 1. Utility decision makers must be involved in your Algal Plan development. Water systems that you sell water to must also know the details of your Algal Plan.

### 3.1 Existing Treatment Processes and Alternative Source Evaluation

A first step in developing a coherent plan is to take stock of your existing water treatment capabilities and limitations relative to removing or eliminating cyanobacteria, algae, and cyanotoxins. This assessment should include alternative water sources that could be used to reduce demands on the surface water treatment facility. Understanding the strengths and weaknesses of your treatment plant helps you identify possible adjustments or additional treatment processes that you can enact to make your system more resilient to meet this potential threat.

Some suggested steps for evaluating existing capabilities are listed below along with information on optimizing treatment performance and additional treatment options for cyanobacteria, algae, and cyanotoxins.

#### **Existing treatment review**

- Identify and describe existing surface water source(s).
- Describe current treatment processes and include a treatment schematic. The treatment schematic in your most recent sanitary survey may be useful.
- Determine whether current processes adequately reduce or eliminate algae, cyanobacteria, and cyanotoxins. Evaluate whether supplemental treatment or operational changes, such as addition of powdered activated carbon or changing the point of oxidant addition, might be needed during bloom season. Refer to Appendix A.1 and EPA guidance.
- Consider whether long-term treatment enhancements are needed (see Section 3.5), if source water is vulnerable and existing treatment is frequently challenged by cyanotoxins.
- Evaluate alternative sources you could use, including interties, groundwater wells, or other surface water sources.

- Consider your ability to decrease water system demands if alternative sources are limited.
- Evaluate both treatment options and alternative source options relative to the time of year and duration. Algal blooms have distinct durations that may vary year to year. For example, a neighboring utility may be able to provide a larger quantity of water for two weeks, but not for months. Water demand reductions in May could be easier to achieve than in August. Even short duration demand reduction or alternative source production may allow your treatment plant to effectively adjust treatment.

#### Treatment adjustments in the event of a bloom

Create a step-by-step plan to be followed in the event of a bloom and in the event of a confirmed health advisory or trigger level exceedance of cyanotoxins in finished water.

- Enact treatment adjustments identified previously. Base treatment adjustments on knowledge about whether the bulk of the cyanotoxin is intracellular or extracellular.
- Activate alternate water sources, including interties with adjacent utilities.
- Reduce plant flowrate to improve cell removal.
- Implement water demand reduction strategies.

#### **Optimize Existing Treatment and Identify Additional Needs**

You can optimize your existing treatment to remove algae cells and oxidize and/or remove cyanotoxins. Through optimization you can also identify new treatment processes that can make your system more resilient to algal blooms. Appendix A.1 along with EPA guidance contains more information on effectiveness of different treatment processes and how best to optimize your existing treatment.

# 3.2 Source Water Observation and Monitoring

Surface water systems should monitor raw water quality and treatment plant performance for changes that may indicate the presence of algal blooms containing cyanobacteria or cyanotoxins. These include:

- Decreased filter run time.
- Increased taste and odor.
- Increased SUVA (Specific ultraviolet absorbance).
- Increased pH from normal levels.
- Increased turbidity.
- Increased coagulant demand.
- Increased chlorine demand.
- Decreased chlorine residual.
- Observations of zooplankton that feed on algae, such as *Daphnia* water flea, in supply lines or raw water equipment like turbidimeters.

Begin your source water observation for algal blooms or monitoring for bloom indicators at the start of each bloom season and continue throughout the bloom season. Continue throughout the year if local climate or bloom history indicates the possibility of blooms year-round.

Some specific actions for source water observation and monitoring are listed below followed by additional resources and suggestions.

- Evaluate any routine source water quality monitoring for all of your surface water sources, which your water utility conducts or has recently conducted.
- Establish a system-specific monitoring schedule, sampling methods, and compile resources to aid identification of bloom indicators in your source water.

#### **Source Water Observation**

Source water observation means visually inspecting surface water sources for algal blooms. The frequency of observation should be related to the probability of an algal bloom developing, which is often seasonal and weather dependent. March through October is the typical bloom season in Washington.

Blooms can occur anywhere in the water column, sometimes appearing as green or blue-green flecks scattered in the water, scums that float on the surface, or as mats that rest on the bottom of the water body.

<u>Washington State Toxic Algae Program</u> has a photo gallery and instructions to the public on how to report a bloom (<u>nwtoxicalgae.org</u>).

The USGS is a useful reference for cyanobacteria identification. <u>usgs.gov/mission-areas/environmental-health/science/new-guide-help-identify-harmful-algal-blooms?qt-science\_center\_objects=0#qt-science\_center\_objects</u>

For some waterbodies, the public is a useful resource in spotting potential source water blooms. It may be valuable to make the information in these links available to your customers.

When a bloom is present, identify phytoplankton to determine whether cyanobacteria are present. This means evaluating water samples under a microscope and identifying the algae and cyanobacteria present. You can do this in-house, by private laboratory, or through the state algal toxin testing program coordinated by the Department of Ecology. Instructions for submitting a sample through the Ecology program are at <a href="mailto:nwtoxicalgae.org/ReportBloom">nwtoxicalgae.org/ReportBloom</a>. Appendix F lists other in-state labs that can do this work.

If cyanobacteria are present then you will need to test the water for cyanotoxins.

#### **Source Water Monitoring**

In addition to visual observations and changes in raw water quality parameters and treatment plant performance listed above, you may choose to regularly monitor source water for bloom indicators. Bloom indicators can detect HABs and cyanobacteria that may not be visible, but may be producing cyanotoxins. Below is a summary of possible HAB or cyanobacteria indicators that you could sample throughout the bloom season and levels that trigger a response. Since some indicators like pH and dissolved oxygen (DO) change through the day, it's important to sample at roughly the same time each day. More information on sampling for these indicators is in the USGS Field Manual, *Lakes and Reservoirs: Guidelines for Study Design and Sampling* (USGS, 2018a) and the USGS *National Field Manual for Collection of Water Quality Data* (USGS, 2018b).

Table 2—Source Water Bloom Indicators

| Bloom indicator                           | Trigger Level <sup>1</sup>  | Response   |
|---|---|--|
| рН  | Increasing from normal levels. pH changes from day to night.  | Evaluate other Bloom Indicators                          |
| Secchi disk depth                         | Reduction in visibility (decrease in secchi depth for example >2 ft.) since prior measurement   | Evaluate other Bloom Indicators                          |
| Lake stratification<br>(temperature & DO) | Temperature and DO levels indicate if lake is stratified. Documenting typical times and degrees of stratification may allow correlation of blooms with certain stratification conditions. | Evaluate other Bloom Indicators                          |
| MIB and/or Geosmin                        | Increase of 20-50 ng/L (or presence if not normally found)  | Take phytoplankton sample for ID at least to genus level |
| Phytoplankton Cell Counts                 | Use historical source water quality to establish # cells/mL   | Take phytoplankton sample for ID at least to genus level |
| Cyanobacteria Cell Counts                 | $\geq$ 2,000 cells/mL $^2$  | Take phytoplankton sample for ID of cyanobacteria        |
| Bio-volumes                               | $\geq$ 0.2 mm $^3/L^2$  | Take phytoplankton sample for ID of cyanobacteria        |
| Chlorophyll-a                             | ≥ 1 µg/L <sup>2,3</sup>   | Take phytoplankton sample for ID of cyanobacteria        |
| Phycocyanin equivalents                   | ≥ 2,000 cells/mL  | Take phytoplankton sample for ID of cyanobacteria        |
| Cyanotoxin Production<br>Genes (qPCR)     | In development  | In development   |

<sup>&</sup>lt;sup>1</sup>Tailor these criteria to your lake or reservoir.

If a bloom is detected, then identifying the cyanobacteria present allows you to focus on cyanotoxins typically produced by that group of cyanobacteria and to establish what toxins to test for in raw or finished water. Appendix B provides a table of cyanobacteria and their associated cyanotoxins.

Consider making operational changes and treatment adjustments discussed in Section 3.1 whenever a bloom is present in the vicinity of the intake.

<sup>&</sup>lt;sup>2</sup>(WHO, 6.3.2, 1999) "Alert Level 1 Thresholds"

<sup>&</sup>lt;sup>3</sup>This trigger level may be too low for your source. For example, the City of Bellingham reports an average median summer near surface chlorophyll a concentration of 2.9  $\mu$ g /L (25-year record) in basin 3 of Lake Whatcom. This is when no bloom is observed—just background summer levels for an oligotrophic portion of the lake.

#### 3.3 Raw and Finished Water Cyanotoxin Monitoring

Should you detect an algal bloom containing cyanobacteria in your source water then raw water sampling for cyanotoxins is warranted. If you detect cyanotoxins in the raw water then finished water cyanotoxin testing is needed to determine if your customers are exposed to cyanotoxins. On-line phycocyanin monitoring of raw water entering the treatment plant can be used to provide an early warning.

We list some key steps for your plan here, along with more in depth considerations for raw water and finished water cyanotoxin monitoring.

- Describe sampling procedures to be followed in the event of confirmed presence of bloom indicators in your source water.
- Establish a monitoring/sampling schedule for cyanotoxins.
- Determine which toxin analysis methods are feasible for your utility, considering your budget and existing lab capability.
- Identify the laboratories available in your area that can perform cyanotoxin sampling, as well as shipping and handling requirements.
- Describe finished water monitoring procedures to be followed in the event of confirmed cyanotoxins in raw water.
- Determine how to expedite receipt of sampling results. This becomes a key factor when assessing risk for cyanotoxins that have a HAL based on a tenday exposure.

#### **Raw Water Monitoring**

If you detect HABs or cyanobacteria indicators in source water at or above trigger levels (Table 2, above), begin raw water monitoring for the specific cyanotoxins associated with the cyanobacteria identified in the bloom according to the schedule in Table 3 (see Appendix C for sampling details).

**Cyanotoxins not Cyanotoxins Not Detected, and Bloom is** Sample Sample **Cyanotoxins Detected, but Bloom** Gone Location Frequency Detected\* observed near Intake Sample finished Continue raw water Stop raw water sampling; Intake prior to 2 times per water within 24 sampling until bloom continue source water treatment week hours is gone observation/monitoring

Table 3: Raw Water Cyanotoxin Sampling Schedule

Cyanotoxins may be present both inside (intracellular) and outside (extracellular) the algal cell and this will likely change over the course of the bloom. Because treatment decisions may depend on where the cyanotoxin is present, analyze raw water samples for both extracellular cyanotoxin and total cyanotoxin. This allows you to calculate intracellular toxin levels (total minus extracellular equals intracellular).

Total cyanotoxin is determined by cell lysing, usually with a freeze/thaw cycle, to release the toxin from within the cells. To determine extracellular toxin the lab will likely need to split the sample and apply a filtration step to one half of the sample. Be sure to discuss this with your lab when arranging for sample analysis.

There are several options available for cyanobacteria and cyanotoxin analysis. Each option has benefits and limitations so it may be useful to use more than one method. Choose the method that works best for your

<sup>\*</sup>Report cyanotoxin analytical results to the ODW within 24 hours of receipt.

utility. Table 4 contains general information about two different analyses. Appendix D contains acceptable analytical methods for different sampling locations.

Table 4: Cyanotoxin Analysis Methods

| Analysis  | Toxins   | Limitations  | Skill Level  | Approximate cost per analysis                             |
|-----------|--|--|--------------|---|
| ELISA kit | Microcystin Cylindrospermopsin Anatoxin-a Saxitoxins | ELISA is a quantitative test and indicates total toxin but does not identify microcystin congeners. A separate ELISA test is required for each of the four listed toxins. Field ELISA test kits indicate the | Intermediate | Capital cost—\$25,000<br>In-house—\$50<br>Lab—\$125-\$150 |
|           |  | presence or absence of toxins. (EPA Method 546 is only applicable to the ELISA microcystin test).  |              |   |
| LC/MS/MS  | Microcystin  Cylindrospermopsin                      | EPA Method 544 & 545<br>quantitative – Indicates specific<br>congeners of toxins not total   | Advanced     | Lab - \$250-\$500   |
|           | Anatoxin-a Saxitoxin                                 | toxins. It is possible to have a non-<br>detect (microcystin) with method<br>544* and positive result with   |              |   |
|           |  | ELISA*. Microcystin variants LA, LF,<br>LR, LY, YR and ADDA containing<br>cyanotoxin nodularin   |              |   |

Table adapted from Utah DEQ (2017)

EPA Methods 544 and 546 (ELISA) results cannot be compared to each other. Results from the same water may differ because the two tests are measuring different things.

The number of in-state labs that offer certified toxin analysis using ELISA and LC/MS/MS is extremely limited. See Appendix F.

#### **Finished Water Monitoring**

If you detect cyanotoxins in raw water, you should begin finished water monitoring for the detected cyanotoxins according to the schedule in Table 5 (see Appendix C for sampling details). To shorten your response time during an event, consider collecting a confirmation sample 24 hours after the initial sample without waiting for initial results. Also consider treatment train monitoring and distribution system monitoring if cyanotoxins are present in raw water. Treatment train monitoring helps you identify potential optimization strategies. Distribution monitoring allows you to provide more accurate and specific health information to customers.

Table 5: Initial Finished Water Cyanotoxin Sampling Schedule

| Sample<br>Location                 | Sample<br>Frequency | Result—Cyanotoxins<br>Detected*  | Result—Cyanotox<br>ins Detected in<br>Raw but Not<br>Finished Water                                       | Result—No<br>Cyanotoxins<br>Detected in Raw or<br>Finished Water  |
|------------------------------------|---------------------|--|---|---|
| Distribution<br>system entry point | 2 times per<br>week | Collect confirmation sample as soon as possible and within 24 hours; if confirmed proceed with follow-up sampling per schedule below | Continue raw and finished water sampling 2 times per week until cyanotoxins are not detected in raw water | Continue <b>raw water</b> sampling 2 times per week until bloom is gone (discontinue finished water sampling) |

<sup>\*</sup>Report cyanotoxin analytical results to the ODW within 24 hours of receipt.

If cyanotoxins are detected by a system in finished water, the water system should continue finished water monitoring for cyanotoxins according to the schedule in Table 6.

Table 6: Follow-up Finished Water Cyanotoxin Sampling Schedule

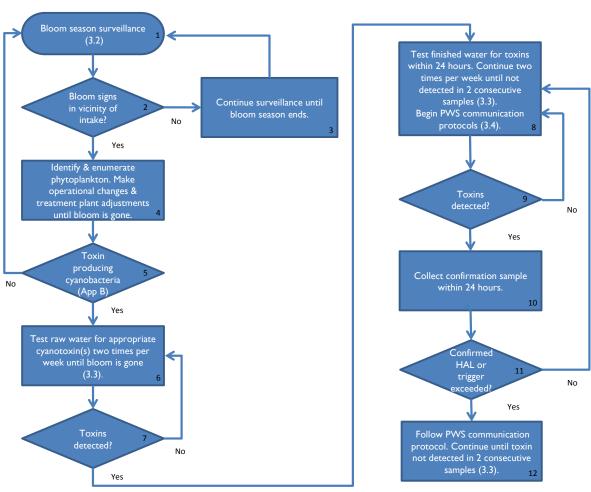
|   |                     | •  |   |
|---|---------------------|--|---|
| Detection Level in Finished Water           | Sample<br>Frequency | How Long?  | Then What?  |
| Cyanotoxins <b>below</b><br>trigger or HAL* | 2 times per<br>week | Until below detection in finished water and below detection in 2 consecutive raw water samples   | Sample raw water 2 times per<br>week if bloom exists; discontinue<br>raw water sampling if bloom is<br>gone |
| Cyanotoxins <b>above</b><br>trigger or HAL* | Daily               | Until below Health Advisory<br>Levels* in 2 consecutive finished<br>water samples, 24 hrs. apart | Sample raw water 2 times per<br>week if bloom exists; discontinue<br>raw water sampling if bloom is<br>gone |

<sup>\*0.3</sup>  $\mu$ g/L for microcystins; 0.7  $\mu$ g/L for cylindrospermopsin; 0.3  $\mu$ g/L for anatoxin-a (see discussion at the end of Section 1.0).

#### **Acceptable Analytical Methods**

You should choose an analytical method suitable to the water being sampled and the intended use of the results. For source water and raw water monitoring, ELISA (enzyme-linked immunosorbent assay) field kits can provide rapid semi-quantitative (presence / absence) results. For finished water analyses, a laboratory certified in the use of approved analytical methods for quantifying cyanotoxins, such as ADDA specific ELISA or LC/MS/MS should be used. Appendix D lists the acceptable analytical methods for the analysis of water samples for each cyanotoxin under various circumstances. Early identification of the nearest laboratories capable of performing cyanotoxin analysis and procurement of field test kits can save precious time during a potentially serious HAB event.

Figure 1-Algal Bloom Surveillance & Response



PWS = public water system

#### 3.4 Communication and Public Notice

**Be First**—When hearing about a new risk, people's perceptions are often shaped by the first message they hear, regardless of the information source. If utilities wait to communicate ... they cede any early advantage to other information sources that could be inaccurate or misleading. Utilities should keep in mind that if they are not the first to communicate to customers about these issues, someone with a different agenda will frame the issues for them. (Henderson, K. et.al, JAWWA, May 2020)

Early and effective communication with your customers is critical for maintaining utility credibility. Systems should fully discuss communication and public notification with their governing body during the Algal Plan development. Systems should also consider communications they will have with customers if cyanotoxins are detected but not yet confirmed, or are confirmed below the health advisory limit.

Some critical considerations for your communication plan are listed below.

• Identify agencies and customers that need to be notified (ODW, local health jurisdiction, consecutive systems, large customers, vulnerable customers, medical facilities).

- Update your Public Notification Plan to include cyanotoxins and develop public communication messages and tools now for:
  - 1) When an algal bloom impacts water quality or treatment,
  - 2) Detection of cyanotoxins in the raw water, and
  - 3) Both the presence of cyanotoxins and the exceedance of cyanotoxin trigger levels in finished water.
- Develop health advisory language for confirmed exceedance of cyanotoxin HALs in finished water (templates provided in Appendix E).
- Draft system-specific public notification templates for reporting finished water cyanotoxin detections in the annual consumer confidence report.
- Determine media outlets to use for rapid and widespread distribution of the health advisory. Use multiple platforms (radio, TV, social media, door hangers) to ensure that the message is delivered to all customers.
- Deliver health advisory in multiple languages if you serve a non-English speaking population.
- Remember that a "do not drink" advisory does not allow customers to boil or treat their water, they must obtain bottled water for cooking and drinking. If you must issue a do not drink advisory, evaluate whether you will offer a supply of alternate emergency water to customers.

If cyanotoxins are detected in finished drinking water follow the recommendations in Table 7 below for when to issue a health advisory.

Table 7: Recommended Health Advisories for Cyanotoxin Detections

| Location                        | Cyanotoxin level                  | Health Advisory  | Follow-up   |
|---------------------------------|-----------------------------------|--|---|
| Raw water only                  | Above detection limit             | Not recommended*   | Continue raw water monitoring according to Table 3  |
| Finished water                  | Below health advisories           | Not recommended *  | Continue finished water monitoring according to Table 6. Include detection in consumer confidence report.             |
| Finished water (initial sample) | At or above the health advisories | Not recommended*   | Monitor according to Table 5.   |
| Finished water<br>(confirmed)   | At or above the health advisories | Issue <b>Do-Not-Drink</b> advisory within 24 hours of receiving the results of the confirmation sample | Issue a second notice removing<br>the advisory after two<br>consecutive finished water<br>samples are below the HALs. |

<sup>\*</sup>Communicate results to customers per your communication plan.

Suggested public notification language is in Appendix E. USEPA provides additional communication templates and resources in its *Risk Communication Toolbox* (epa.gov/ground-water-and-drinking-water/drinking-water-cyanotoxin-risk-communication-toolbox-templates). As with any public notice, systems should distribute the notice to all wholesale customers and consider vulnerable populations. Frequently asked questions for utility customers based on the Salem Oregon HABs event are on Oregon Health Authority's HAB resource website.

(oregon.gov/oha/PH/HealthyEnvironments/DrinkingWater/Operations/Treatment/Pages/algae)

### 3.5 Long Term Planning

All water systems in Washington state are required to prepare comprehensive water system plans (WSP). Some aspects of your Algal Plan dovetail nicely with water system planning for water utilities. Three areas of an algal plan effort to possibly include in your WSP efforts are:

- 1. Identify treatment improvements that can remove algae or destroy cyanotoxins. For example dissolved air flotation (DAF) is very effective at removing suspended algae from water. (DAF may extend filter runs in non-bloom conditions as well).
- 2. Identify long term measures to detect, mitigate, and prevent future algal blooms. Some examples include reservoir mixing, or water treatment plant intake modifications. Some additional ideas are provided below.
- 3. Manage/reduce nutrients. Appendix A.4 shows how risk of algal blooms can be reduced by controlling phosphorus. This is something that could be included in your watershed management efforts.

Source water monitoring and an understanding of the biology and chemistry of the source water can help identify potential management and control measures to reduce both the frequency and magnitude of algal blooms and subsequent levels of cyanobacteria entering your water treatment plant. USEPA provides an overview of source water mitigation strategies in Section 2.4 of *Recommendations for Systems to Manage Cyanotoxins in Drinking Water* (USEPA, 2015a). Systems in Washington have successfully achieved long term positive results by using:

- Mechanical lake mixing,
- Variable intake depths, and
- Spatially separated intakes in the lake or impoundment. (This allows these utilities to avoid algal blooms that occur in only part of their lake or impoundment.)

Other methods used across the country include the addition of alum or bentonite clay (Phoslock®) to remove phosphorous from the water and bind it in lake sediments, and in-lake aeration and oxygenation. Algaecides are not recommended because they fail to correct the underlying cause of the bloom, only provide short term results, can disrupt the ecology of the water body, and most importantly, can release toxins contained inside cyanobacterial cells.

One last consideration for long term planning. A couple of systems in Washington have experienced significant algal blooms following modification to their source impoundments (raising a dam). The newly flooded land most likely released nutrients to the source water and certainly changed the historical water quality conditions. Any planned source modifications should anticipate possible algal blooms and evaluate possible mitigation efforts.

#### 4.0 Where to Get Help

While it is the primary responsibility of the affected system to prepare and manage potential HAB events, ODW, Ecology, and several other agencies can assist in the response to algal blooms and cyanotoxins as described below.

#### **Department of Health-Office of Drinking Water (ODW)**

Provides technical assistance and advice about sampling, treatment options, and public notice by systems affected by HABs and cyanotoxins. ODW's responses to HABs that affect systems include the following.

- ODW maintains a list of systems known to be vulnerable to algal blooms (Appendix A.2).
- If requested, ODW will review your Algal Plan and keep on file.
- ODW follows up with a system when an algal bloom, cyanobacteria, or cyanotoxins have been detected in source water.
- ODW provides technical assistance to systems that detect cyanotoxins in raw or finished water.
- ODW assists systems in reviewing the adequacy of facilities for treating algae and cyanotoxins.
- ODW reviews plans for providing temporary treatment of cyanotoxins.
- ODW reviews plans for constructing permanent facilities to treat algae and cyanotoxins.
- ODW will assist systems with health advisories if cyanotoxins are detected in finished water

For more information contact your ODW regional office.

<u>Northwest Regional Office</u> 509-329-2100 Southwest Regional Office 253-395-6750 Southwest Regional Office 360-236-3030

# **Department of Health-Office of Environmental Public Health Sciences**

- Provides support to local health jurisdictions (LHJs) on recreational and drinking water HABs-related issues.
- Provides epidemiological and toxicological expertise on cyanotoxin health effects.
- Provides health effects advice for cyanotoxin detections without established HALs.
- Provides recommended public health actions to take when there is an active bloom in a recreational water body.
- Provides outreach materials and warning signs for recreational water HABs.

#### **Department of Ecology (Ecology)**

• Implements the Fresh Water Algae Control Program, which:

- Provides phytoplankton identification and enumeration and cyanotoxin testing through the King County Environmental Lab.
- Maintains a publically available database of cyanotoxin testing of Washington water bodies.
- Administers a program to provide small grants of up to \$50,000 to state agencies, cities, counties, tribes, and special purpose districts to fund projects that prevent, remove, reduce, or manage cyanobacteria.

#### **Local Health Jurisdictions**

Local health jurisdictions may report algal blooms, collect samples, and provide information concerning algal blooms and cyanotoxins to local residents. Many LHJs monitor beaches and other freshwater recreational sites and post health advisories based on <u>state recreational HABs guidelines</u>. They may also close beaches and recreational sites if they are above recreational guidelines. (<u>doh.wa.gov/CommunityandEnvironment/Contaminants/BlueGreenAlgae/Resources</u>)

LHJs normally refer public water system-related questions to ODW. Some LHJs regulate very small public water systems (group B) either through a local ordinance or delegated responsibility from the Department of Health.

Contact your <u>local health jurisdiction</u> for details on their program. (doh.wa.gov/AboutUs/PublicHealthSystem/LocalHealthJurisdictions)

#### **US Environmental Protection Agency (EPA)**

USEPA "Cyanobacterial Harmful Algal Blooms (CyanoHABs) in Water Bodies" webpage contains a wealth of information. (epa.gov/cyanohabs)

# **Appendix A.1—Algae and Cyanobacteria Treatment Optimization and Resources**

Systems with sources vulnerable to cyanotoxin contamination should assess adequacy of treatment and, if necessary, make treatment adjustments based on past experience treating cyanotoxins or upon recommendations by USEPA. The specific treatment required may depend on the type of cyanotoxin present, the level of cyanotoxins in the raw water, and whether the cyanotoxins are intracellular or extracellular. Existing surface water treatment may be effective in reducing cyanotoxins to an acceptable level.

For example, conventional surface water treatment, (coagulation, flocculation, sedimentation, and filtration) has been shown to effectively remove intracellular cyanotoxins, but has limited ability to remove extracellular toxins. In some cases, treatment adjustments or the addition of treatment processes may be needed.

Systems with existing surface water treatment facilities may be able to adjust treatment to respond sufficiently to cyanotoxins. EPA lists the following commonly used treatment strategies for reducing or eliminating cyanotoxins:

- Remove intact cells containing intracellular cyanotoxins by optimizing existing coagulant chemicals and chemical doses.
- Minimize pre-filtration oxidation of raw water to reduce the risk of releasing intracellular cyanotoxins. (Reminder: If you use pre-filtration oxidation to meet disinfection CT requirements, you may need to adjust the postfiltration disinfection process to achieve your overall CT required.)
- Add or increase the use of powdered activated carbon (PAC) to adsorb dissolved or extracellular cyanotoxins. (Caution: systems with membrane filtration should consult with the equipment manufacturer to see if the membranes can tolerate upstream PAC addition.)
- Increase post-chlorination to oxidize certain extracellular cyanotoxins (caution: this could potentially increase the formation of Disinfection Byproducts).

If adjustments to existing treatment facilities do not sufficiently reduce cyanotoxin levels or a system does not have the ability to make treatment adjustments to respond to cyanotoxins, it may be able to shut down the intake and rely on another source, unaffected by cyanotoxins, until the threat from cyanotoxins has passed. If a system is unable to shut down the source or treat to acceptable levels, it must consider installing additional treatment facilities. EPA suggests the treatment options listed below for removing intracellular and extracellular cyanotoxins.

#### **Additional Treatment Options for Intracellular Cyanotoxins (Cell Removal)**

- 1. Dissolved Air Flotation
- 2. Microfiltration and Ultrafiltration

The key to treatment of intracellular cyanotoxins is to remove cyanobacteria cells and limit the release of toxins from the cells. This typically requires a water system to limit algaecide application to source water and stop or limit pre-oxidation during treatment. A water system must consider, however, how changes in pre-oxidation affect other treatment goals.

#### **Additional Treatment Options for Extracellular Cyanotoxins**

- 1. Oxidation
- 2. Granular Activated Carbon
- 3. Powdered Activated Carbon
- 4. Biological Filtration
- 5. Nanofiltration and Reverse Osmosis
- 6. Ultraviolet Light with Hydrogen Peroxide

Once cyanobacteria release cyanotoxins, cell removal does little to reduce toxins dissolved in the water. Therefore, conventional surface water treatment, microfiltration, and ultrafiltration are no longer effective. Extracellular, or dissolved, cyanotoxins must be removed through treatment processes such as adsorption, molecular filtration, or oxidation.

General effectiveness of oxidizing agents on various cyanotoxins is described in Table 3-1 of USEPA's *Water Treatment Optimization for Cyanotoxins* (Version 1.0) (USEPA, 2016) shown below. Oxidation by ozone is especially effective in destroying most cyanotoxins.

| Oxidant                   | Anatoxin-a                    | Cylindrospermopsin   | Microcystins                  | Saxitoxin              |
|---------------------------|-------------------------------|--|-------------------------------|------------------------|
| Chlorine                  | Not effective                 | Effective (at low pH)                                      | Effective*                    | Somewhat effective     |
| Chloramine                | Not effective                 | Not effective  | Not effective at normal doses | Inadequate information |
| Chlorine dioxide          | Not effective at normal doses | Not effective  | Not effective at normal doses | Inadequate information |
| Potassium<br>permanganate | Effective                     | Data ranges from<br>not effective to<br>possibly effective | Effective*                    | Not effective          |
| Ozone                     | Effective                     | Effective  | Very effective                | Not effective          |
| UV / advanced oxidation   | Effective                     | Effective  | Effective at high UV doses*   | Inadequate information |

<sup>\*</sup> Dependent on initial cyanotoxin concentration, pH, temperature, and presence of NOM.

Other oxidants such as chlorine, potassium permanganate, and UV vary in their effectiveness to remove a given cyanotoxin. <a href="CyanoTOX® Version 3.0">CyanoTOX® Version 3.0</a> is an oxidation calculator designed to help utilities evaluate how treatment adjustments (such as pH, oxidant dose, and contact time) may influence degradation of individual cyanotoxins and some groups of cyanotoxins. <a href="Important: to account for differences">Important: to account for differences between laboratory and real-world results, apply a safety factor of at least 2.0 to CyanoTox results.

ODW can provide assistance in reviewing the adequacy of cyanotoxin treatment or evaluating options to install additional treatment. Installation of cyanotoxin treatment requires that plans be submitted to ODW for review and approval prior to construction.

**Appendix A.2—Washington Surface Water Systems Vulnerable to Algal Blooms and/or HABs** 

| PWS Name                                    | County       | PWS ID | Source                | Comments  |
|---|--------------|--------|-----------------------|---|
| Aberdeen, City of                           | Grays Harbor | 00050  | Wishka River<br>(S01) | Upstream impoundment.<br>Membrane (microfiltration)<br>installed.   |
| Autumn Lane<br>(group B)                    | Whatcom      | 03421  | Lake Samish           | Lake source. Cyanobacterial blooms 2001 & 2002. 2003 late summer/fall Toxins ND.  |
| Bear Mountain<br>Water District             | Chelan       | 07155  | Lake Chelan           | Lake source.  |
| Bellingham                                  | Whatcom      | 05600  | Lake Whatcom          | Lake source with cyanotoxin detection*. 2009 algal bloom (Aphanothece) caused filter clogging. DAF installed.                         |
| Blakely Island<br>Maintenance<br>Commission | San Juan     | 18539  | Horseshoe<br>Lake     | Lake source.  |
| Calmor Cove                                 | Whatcom      | 10562  | Lake Samish           | Lake source. Cyanobacterial blooms 2001 & 2002. 2003 late summer/fall Toxins ND.  |
| Camp<br>Lutherwood                          | Whatcom      | 12641  | Lake Samish           | Lake source. Cyanobacterial blooms 2001 & 2002. 2003 late summer/fall Toxins ND.  |
| Carson                                      | Skamania     | 11340  | Bear Creek            | Small raw water impoundment.<br>Algae clogs intake screens in<br>summer/fall.   |
| Chelan Water<br>Department                  | Chelan       | 12300  | Lake Chelan           | Lake source.  |
| Chinook Water<br>District                   | Pacific      | 12800  | Freshwater<br>Creek   | Raw water impoundment (1.5 Ac).<br>2018 bloom (Aphanizomenon,<br>Microcystis, Oscillatoria). Membrane<br>(ultrafiltration) installed. |
| Coulee Dam<br>Water<br>Department           | Okanogan     | 15400  | Lake Roosevelt        | Lake source (adjacent to Grand Coulee Dam).   |

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| PWS Name                               | County    | PWS ID | Source                                      | Comments  |
|--|-----------|--------|---|---|
| Crescent Water<br>Association          | Clallam   | 16020  | Lyre River                                  | Source downstream from Crescent<br>Lake, lake source with cyanotoxin<br>detection.* 1994 spring algal<br>bloom.                           |
| Doe Bay Water<br>Users Assoc           | San Juan  | 19600  | Mountain Lake                               | Lake source.  |
| Eastsound                              | San Juan  | 22170  | Purdue Lake<br>Reservoir                    | Lake source. Two intakes: one floating, one fixed.  |
| Everett Public<br>Works Dept.          | Snohomish | 24050  | Lake Chaplain<br>Reservoir,<br>Spada Lake   | Lake source. Daphnia-water fleas that eat algae.  |
| Friday Harbor,<br>Town of              | San Juan  | 26595  | Trout Lake and<br>Aug 1 & 2                 | Lake source. Installed Solar Bees in Trout Lake. GAC installed.   |
| Ilwaco                                 | Pacific   | 35500  | Indian Creek                                | Raw water impoundment.  |
| Lake Chelan<br>Reclamation<br>District | Chelan    | 43783  | Lake Chelan                                 | Lake source.  |
| Lake Margaret<br>Water System          | King      | 44200  | Lake Margaret                               | Lake source with cyanotoxin detection.* Ozone prior to SSF. Sampled about 2015. Toxins ND.  |
| Lakedale Water<br>System               | San Juan  | 45085  | Neva Lake                                   | Lake source. Algae clogging bag filters, installed SSF pre-filter to address.   |
| LISECC                                 | Whatcom   | 43290  | Dickinson Lake                              | Lake source. Algal blooms 2019 and 2020.  |
| Little Butte                           | Chelan    | 49120  | Lake Chelan                                 | Lake source.  |
| Log Cabin                              | Clallam   | NP570  | Lake Crescent                               | Lake source with cyanotoxin detection.*   |
| Long Beach<br>Water<br>Department      | Pacific   | 48000  | Main<br>Impoundment,<br>Dohman<br>Reservoir | Raw water impoundments. Taste/odor issues 2019 (Oscillatoria), toxins ND. May, 2019 UCMR4: HABs ND. Membrane (microfiltration) installed. |

| PWS Name                                  | County    | PWS ID | Source                             | Comments  |
|---|-----------|--------|------------------------------------|---|
| LWWSD-South<br>Shore Water<br>System      | Whatcom   | 95910  | Lake Whatcom                       | Lake source with cyanotoxin detection.*   |
| McHaven                                   | Skagit    | 44357  | Lake<br>McMurray                   | Lake source with cyanotoxin detection.* Clogging bag filters.   |
| McNeil Island<br>Water                    | Pierce    | 52900  | Eden Creek,<br>Butterworth<br>Lake | Lake source.  |
| Olga                                      | San Juan  | 63400  | Cascade<br>Stream                  | Downstream from Cascade Lake  |
| Port Townsend                             | Jefferson | 69000  | City Lake,<br>Lords Lake           | Raw water impoundment. 2016-<br>cyanobacteria identified in both raw<br>water impoundments. Toxins ND.<br>Membrane (ultrafiltration) installed. |
| Roche Harbor<br>Water System<br>Inc.      | San Juan  | 73230  | Briggs Lake                        | Lake source. Algae problems<br>worsened after dam was raised. UW<br>lake observations 2014. GAC<br>installed.                                   |
| Rosario                                   | San Juan  | 74270  | Cascade Lake                       | Lake source. DAF installed. Ozone installed.  |
| Ryderwood<br>Improvement &<br>Service     | Cowlitz   | 75100  | Campbell<br>Creek                  | Small raw water impoundment.  |
| Seattle Public<br>Utilities-Cedar         | King      | 77050  | Cedar River,<br>Lake Youngs        | Raw water impoundments. Can bypass Lake Youngs. Ozone installed.  |
| Seattle Public<br>Utilities-Tolt          | King      | 77050  | S Fork Tolt<br>River               | Raw water impoundment. Ozone installed.   |
| Skagit County<br>PUD 1 Judy Res           | Skagit    | 79500  | Judy Reservoir                     | Raw water impoundment. T&O problems in 2003, 2005 after dam was raised.   |
| Spring Point<br>Homeowners<br>Association | San Juan  | 83335  | Jay & Clyde<br>Lakes               | Lake source. GAC installed.   |

| PWS Name                             | County    | PWS ID | Source   | Comments   |
|--------------------------------------|-----------|--------|--|--|
| Stevens Pass<br>Water System         | King      | 84245  | Tye Reservoir                                  | Lake source.   |
| Stevenson                            | Skamania  | 84250  | La Bong Creek,<br>Cedar Springs,<br>Rock Creek | One of the creek sources has a raw water settling basin.   |
| Sultan Water<br>Department           | Snohomish | 84770  | Lake #16                                       | Lake source.   |
| Sun Mountain<br>Resort               | Okanogan  | 85135  | Patterson Lake                                 | Lake source.   |
| Sunnybank<br>Water System            | Chelan    | 01266  | Lake Chelan                                    | Lake source.   |
| Sunrise No 12                        | Pierce    | NP850  | Frozen Lake                                    | Lake source.   |
| Tacoma Water<br>Division City of     | Pierce    | 86800  | Howard<br>Hanson<br>Reservoir                  | Ozone installed for taste/odor.  |
| Transalta<br>Centralia<br>Generation | Lewis     | 65484  | Skookumchuc<br>k River                         | Raw water impoundment.   |
| Water District 19                    | King      | 38900  | Beall/Ellis<br>Creeks                          | Attempted pre-chlorination after the 2008 survey to control algae growth on filters, but abandoned this process because it proved to be ineffective. Currently adding chlorine once/week during backwash cycle to reduce algae in backwash pond. |

ND=not detected

<sup>\*</sup>Cyanotoxins were detected in the waterbody, not in public water system intake (See A.2).

**Appendix A.3—Washington Waterbodies with Public Water System Intakes and Cyanotoxin Detections** 

|                |         | 2000000000              |  |
|----------------|---------|-------------------------|--|
| Name           | County  | Cyanotoxin detected*    | Date/Concentration   |
| Crescent Lake* | Clallam | Anatoxin-a, Microcystin | 10/1/2019 Anatoxin-a 0.010 μg/L;<br>Microcystin 0.968 μg/L |
| Lake Margaret* | King    | Anatoxin-a              | 06/05/2017 0.027 μg/L                                      |
| Lake McMurray* | Skagit  | Microcystin             | 09/21/2015 0.160 μg/L 08/10/2015<br>1.160 μg/L             |
| Lake Whatcom*  | Whatcom | Microcystin             | 12/12/2017 Microcystin 0.200 μg/L                          |

Source: Freshwater Sampling Program database. Accessed 5.13.2020.

<sup>\*</sup>Cyanotoxins were detected in the waterbody, not in public water system intakes.

# **Appendix A.4—Impact of Phosphorus on Bloom Risk**

| Risk                | History of<br>Cyanobacteria | Water<br>Temp (°C) | Total P<br>(ug/L) |
|---------------------|-----------------------------|--------------------|-------------------|
| Very Low<br>(Good)  | No                          | <15                | <10               |
| Low                 | Yes                         | <15-20             | <10               |
| Moderate            | Yes                         | 20-25              | 10-25             |
| High                | Yes                         | >25                | 25-100            |
| Very High<br>(Poor) | Yes                         | >25                | >100              |

One pound of phosphorus can create 700 pounds of algae (Reference *Historical Perspectives on the Phosphate Detergent Conflict, Knud-Hansen*, 1994.) For this reason, the amount of phosphate in laundry soaps has been limited to less than 0.5 percent by weight in Washington state since 1994, and this limit applied to dishwasher detergents starting in July 2010. (Sam Perry, Washington Department of Health, *Potential Risks from Algae Blooms in Water Supplies*, AWWA-Pacific Northwest Section, Annual Conference, April, 2018.)

# **Appendix B—Cyanobacteria and Associated Toxins They May Produce**

|   | Hepatotoxins |              | Neui     | rotoxins   | <b>Tastes and Odors</b> |     |
|---|--------------|--------------|----------|------------|-------------------------|-----|
|   | Cylindro-    |              |          |            |                         |     |
| Cyanobacterial Genera   | Spermopsin   | Microcystins | Anatoxin | Saxitoxins | Geosmin                 | MIB |
| Anabaenopsis  |              | Х            |          |            |                         |     |
| Aphanizomenon   | Х            | Х            | Х        | Х          | Х                       |     |
| Aphanocapsa   |              | Х            |          |            |                         |     |
| Arthrospira   |              | Х            | Х        |            |                         |     |
| Chrysosporum  | X            |              |          |            |                         |     |
| Cuspidothrix  | X            | Х            | Х        | X          | Х                       |     |
| Cylindrospermum   | X            |              | X        | X          |                         |     |
| Dolichospermum<br>(Anabaena)                                  | Χ            | Х            | X        | X          | Х                       |     |
| Fischerella   |              | X            |          |            | X                       |     |
| Gloeotrichia  |              | X            |          |            |                         |     |
| Hapalosiphon  |              | Х            |          |            |                         |     |
| Hyella  |              |              |          |            | X                       | Χ   |
| Leptolyngbya (Plectonema)                                     |              | X            |          |            | X                       | Х   |
| Limnothirix   |              | X            |          |            |                         |     |
| Lyngbya (Microseira)  | X            | X            |          | X          | X                       | Χ   |
| Merismopedia  |              | X            |          |            |                         |     |
| Microcystis   |              | X            |          |            |                         |     |
| Nostoc  |              | Х            |          | Х          | Х                       | Χ   |
| Oscillatoria  | Х            | X            | X        | X          | X                       | Χ   |
| Planktothrix  | X            | X            | X        | X          | X                       | Х   |
| Phormidium<br>(Anagnostidinema,<br>Geitlerinema, Microcoleus) |              | Х            | X        | X          | X                       | Х   |
| Pseudanabaena   |              | Х            |          |            |                         | Х   |
| Raphidiopsis<br>(Cylindrospermop-sis)                         | Χ            | X            | Х        | X          |                         |     |
| Scytonema   |              | Х            |          |            |                         |     |
| Snowella  |              | X            |          |            |                         |     |
| Synechococcus   |              | Х            |          |            | Х                       | Х   |
| Synechocystis   |              | Х            |          |            |                         |     |
| Umezakia  | Х            | Х            |          |            |                         |     |
| Woronichinia  |              | Х            | X        |            |                         |     |

MIB is 2-methylisoborneol, a compound commonly associated with taste and odor complaints along with geosmin. Adapted from: Public Water System Harmful Algal Bloom Response Strategy, Ohio EPA, April 2020.

## **Appendix C—Cyanotoxin Sample Handling and Details**

- **Handling**—follow collection and handling procedures established by method or laboratory.
- Lab Analysis—use lab-provided sample containers.
- **Containers**—typically 500 ml amber glass with PTFE-lined cap.
- **Quenching**—quench immediately upon sampling if exposed to oxidants (follow lab instructions).
- **Cooling**—cool on ice (≤10° C) immediately after collection, during shipping, and pending analysis (EPA Method 546).
- Holding Time—analyze within fourteen days of collection (EPA Method 546).

Important: Follow the specific instructions provided by your lab.

# **Appendix D—Acceptable Analytical Methods for Cyanotoxin**

| Toxin              | Source/Raw Water<br>Investigations | Finished Water<br>Investigation | Finished<br>Water<br>Confirmation |
|--------------------|------------------------------------|---------------------------------|-----------------------------------|
| Microcystins       | EPA 546 ADDA ELISA                 | EPA 546 ADDA ELISA              | EPA 546 ADDA ELISA                |
|                    | LC/MS/MS*                          | EPA 544 LC/ESI-MS/MS            | EPA 544 LC/ESI-MS/MS              |
| Anatoxin-a         | Anatoxin-a ELISA                   | Anatoxin-a ELISA                | NA                                |
|                    | LC/MS/MS *                         | EPA 545 LC/ESI-MS/MS            | EPA 545 LC/ESI-MS/MS              |
| Cylindrospermopsin | Cylindrospermopsin<br>ELISA        | Cylindrospermopsin<br>ELISA     | NA                                |
|                    | LC/MS/MS *                         | EPA 545 LC/ESI-MS/MS            | EPA 545 LC/ESI-MS/MS              |
| Saxitoxin          | Saxitoxin ELISA                    | Saxitoxin ELISA                 | Saxitoxin ELISA                   |
|                    | LC/MS/MS*                          | LC/MS/MS                        | LC/MS/MS                          |

<sup>\*</sup>LC/MS/MS methods may require cleanup/solid-phase extraction of thick blooms prior to instrument analysis.

EPA Approved Lab Methods for Cyanotoxins in drinking water:

- 1. EPA Method 544: Microcystin-LA, Microcystin-RR, Microcystin-LF, Microcystin-YR, Microcystin-LR, Microcystin-LY, Nodularin (LC/MS/MS).
- 2. EPA Method 545: Cylindrospermopsin, Anatoxin-a (LC/ESI-MS/MS).
- 3. EPA Method 546: Total Microcystins (ELISA).

# **Appendix E—Public Notification/Water Use Advisories for Cyanotoxins in Drinking Water**

#### Health Advisory Levels for Microcystins, Cylindrospermopsin, and Anatoxin-a

Cyanotoxins are currently not regulated by EPA and do not have maximum contaminant levels (MCLs). However, they are on EPA's Contaminant Candidate List (CCL), and are thereby under consideration for future regulation under the Safe Drinking Water Act. In 2015 the EPA established ten-day non-regulatory HALs for total microcystins and cylindrospermopsin (USEPA, 2015b and 2015c). The health advisories identify concentrations at or below which no adverse human health effects would be expected for up to ten days of exposure. The EPA issued health effects documents for microcystin, cylindrospermopsin, and anatoxin-a along with the 2015 HALs but did not include an acute reference dose for anatoxin-a (USEPA, 2015d), as adequate toxicity data were not available at the time.

HALs for microcystin and cylindrospermopsin are given for two separate population groups. The first group includes infants, pre-school children under six years, and susceptible adults (pregnant women, nursing mothers, elderly, immune-compromised, and dialysis patients). The second group includes school-aged children (six years and older) and other adults.

Table E1: Cyanotoxin Do Not Drink Health Advisory Levels (EPA)

| 10-DAY HEALTH ADVISORIES                                | LEVEL      |
|---|------------|
| Microcystins  |            |
| Children pre-school age and younger (under 6 years old) | 0.3 μg/L   |
| School-age children (6 years and older)                 | 1.6 µg/L   |
| Cylindrospermopsin                                      |            |
| Children pre-school age and younger (under 6 years old) | 0.7 μg/L   |
| School-age children (6 years and older)                 | 3.0 μg/L   |
| Table 1. U.S. EPA's National 10-Day Health              | Advisories |

Public Notification Templates for EPA HALs are provided below.

- Cylindrospermopsin Above Health Advisory Value for Bottle-Fed Infants and Young Children of Pre-School Age but Below Health Advisory Value for School-Age Children through Adults.
- 2. Cylindrospermopsin Above Health Advisory Value All Consumers.
- 3. Microcystins Above Health Advisory Value for Bottle-Fed Infants and Young Children of Pre-School Age but Below Health Advisory Value for School-Age Children through Adults.
- 4. Microcystins Above Health Advisory Value All Consumers.

# DRINKING WATER WARNING

#### **Cylindrospermopsin Health Advisory**

| The   | •  | , located in<br>cylindrospermopsin.  | County is contaminated with  |
|---|--|--|--|
| detected in our treated   | drinking water. A san<br>. The Washington Dep  | nple collected on<br>partment of Health rec                                | called blue-green algae) has been shows cylindrospermopsin at ommends the following individuals <b>DO</b> ove 0.7 μg/L:  |
|   |  | •  | t women, nursing mothers, those with elderly, and immune-compromised   |
| •   | vomiting, diarrhea, or   | impaired liver or kidne  | over the action level may result in ey function. Seek medical attention if you   |
| formula, making ice, br   | ushing teeth, and prep<br>men, nursing mothers   | paring food for bottle-<br>, those with pre-existin                        | ould be used for drinking, making infant<br>fed infants, children younger than six<br>ng liver conditions, those receiving<br>als.   |
| Water may be used by flushing toilets. Childre                        | all individuals for bath<br>n younger than six yea<br>water. After bathing p                       | ning, washing hands, wars of age must be sup<br>provide a final rinse of   | ies listed above may drink the water.<br>vashing dishes, doing laundry, and<br>pervised while bathing to prevent<br>skin with uncontaminated water for                     |
| Dispose of all ice and naccess to these produc                        | •  | with contaminated w  | ater if individuals described above have   |
| Pets should be given a illness.                                       | ternative water. Conta   | ict a veterinarian imme  | ediately if pets or livestock show signs of  |
| <b>Do not boil the water</b> concentrated as a result                 | •  | not destroy cylindros  | permopsin and it may become more   |
| bloom (HAB). We are visituation. We are making continue to sample out | a source of drinking w<br>working closely with long<br>adjustments to our<br>water. We will keep y | cal and state public he<br>treatment processes t<br>ou informed as the sit | eem, is experiencing a harmful algal<br>ealth agencies to address and resolve the<br>o reduce cylindrospermopsin and we will<br>uation is resolved. Additional information |
| For more information  |  |  | water/cyanotoxins-drinking-water.<br>at  |
| Please share this informat  | ion anyone who drinks ti<br>ble in apartments, nursin  | his water, especially those<br>g homes, schools and bus                    | e who may not have received this notice sinesses). You can do this by posting this notice  |
| This notice is sent to yo   | ou by  | system o   | on//   |

#### **DRINKING WATER WARNING**

## Cylindrospermopsin Health Advisory

| The  | system, ID  | , located in   | County is contaminated with   |
|--|---|--|---|
| detected in our treate   | a compound produced bed drinking water. A sam   | ple collected on   | o called blue-green algae) has been shows cylindrospermopsin at tment of Health recommends all  |
| individuals <b>DO NOT</b>  | DRINK THE WATER who   | en the cylindrosperm   | opsin level is above 3.0 μg/L:  |
| abdominal pain, feve<br>years of age, pregnar<br>pre-existing liver con<br>general population to | r, vomiting, diarrhea, or in<br>nt women, nursing mothe<br>ditions and those receivin | mpaired liver or kidners, the elderly, immung dialysis treatment indrospermopsin. Se | n over the action level may result in ley function. Children younger than six une-compromised individuals, those with may be more susceptible than the lek medical attention if you or anyone in        |
| What should I do?  |   |  |   |
|  | ch as commercially-availa<br>brushing teeth, and prep                                 |  | nould be used for drinking, making infant   |
| younger than six year  | rs of age must be supervi<br>e a final rinse of skin with                             | ised while bathing to  | oing laundry, and flushing toilets. Childrer<br>prevent accidental ingestion of water.<br>ter for people with open wounds or skin   |
| Dispose of all ice and   | mixed beverages made  | with contaminated v  | vater.  |
| Pets should be given illness.  | alternative water. Contac   | t a veterinarian imm   | ediately if pets or livestock show signs of   |
| <b>Do not boil the wate</b> concentrated as a res  | •   | not destroy cylindro   | spermopsin and it may become more   |
| What happened? W   | hat is being done?  |  |   |
| bloom (HAB). We are situation. We are make continue to sample o                                  | e working closely with looking adjustments to our tur water. We will keep yo          | cal and state public hareatment processes ou informed as the si                      | etem, is experiencing a harmful algal nealth agencies to address and resolve the to reduce cylindrospermopsin and we will tuation is resolved. Additional information water/cyanotoxins-drinking-water. |
| For more information   | ı, please contact   | a  | t   |
| notice directly (for exc   |   | nts, nursing homes, s  | lly those who may not have received this chools and businesses). You can do this by r mail.   |
| This notice is sent to   | you by  | system   | on/   |

# DRINKING WATER WARNING Microcystins Health Advisory

| The  | system, ID  | , located in  | County is   |
|--|---|---|---|
|  | contaminated with   | h microcystins.   |   |
| Microcystins are compounds produced been detected in our treated drink micrograms/liter (µg/L). The Wash DO NOT DRINK THE WATER who  | king water. A sample c<br>iington State Departm                               | ollected onent of Health recor  | _ shows microcystins at<br>mmends the following individuals   |
| Bottle-fed infants and child with pre-existing liver concompromised individuals.   | , ,   |   | t women, nursing mothers, those<br>t, the elderly, and immune-  |
| Consuming water containing concliver function, diarrhea, vomiting, your family is experiencing any of  | nausea, numbness or o   |   | •   |
| What should I do?  |   |   |   |
| Alternative water, such as commer<br>formula, making ice, brushing teet<br>years old, pregnant women, nursing<br>dialysis treatment, the elderly, and                      | th, and preparing food<br>ng mothers, those with                              | I for bottle-fed infa<br>n pre-existing liver (                       | nts, children younger than six  |
| Healthy children above the age of Water may be used by all individu flushing toilets. Children younger accidental ingestion of water. Afte people with open wounds or skin | als for bathing, washir<br>than 6 years of age mo<br>er bathing provide a fir | ng hands, washing oust be supervised was rinse of skin with           | dishes, doing laundry, and while bathing to prevent   |
| Dispose of all ice and mixed bever access to these products.   | ages made with conta  | ıminated water if in  | ndividuals described above have   |
| Pets should be given alternative willness.   | ater. Contact a veterin   | narian immediately  | if pets or livestock show signs of  |
| <b>Do not boil the water.</b> Boiling the concentrated as a result of boiling  |   | y microcystins and  | it may become more  |
| What happened? What is being   | done?   |   |   |
| , a source of bloom (HAB). We are working clo situation. We are making adjustme continue to sample our water. We about HABs can be found at epa.g                          | sely with local and sta<br>ents to our treatment  <br>will keep you informe   | te public health ago<br>processes to reduce<br>ed as the situation is | encies to address and resolve the<br>e microcystins and we will<br>s resolved. Additional information |
| For more information, please cont  | act   | at  | ·   |
| Please share this information anyo<br>notice directly (for example, people<br>posting this notice in a public place  | in apartments, nursing  | g homes, schools ar   | -   |
| This notice is sent to you by  |   | system on /   | /   |

# DRINKING WATER WARNING Microcystins Health Advisory

| The   | system, ID   | , located in  | County is  |
|---|--|---|--|
| Microcystins are compounds probeen detected in our treated driming micrograms/liter (µ individuals <b>DO NOT DRINK TH</b>   | inking water. A sample co<br>lg/L). The Washington St                                | (also called blue-go<br>bllected onate Department of H              | shows microcystins at<br>Health recommends all   |
| Consuming water containing co liver function, diarrhea, vomiting pregnant women, nursing moth liver conditions and those received to the health effects of microcysany of these symptoms. | g, nausea, numbness or d<br>ers, the elderly, immune-<br>ving dialysis treatment m   | izziness. Children yo<br>compromised indiv<br>ay be more suscept    | ounger than six years of age, iduals, those with pre-existing ible than the general population |
| What should I do?   |  |   |  |
| Alternative water, such as comm<br>formula, making ice, brushing te   | •  |   | sed for drinking, making infant  |
| Water may be used for bathing, younger than six years of age m After bathing provide a final ring conditions such as eczema.  | ust be supervised while b  | pathing to prevent a  | accidental ingestion of water.   |
| Dispose of all ice and mixed bev  | verages made with contain  | minated water.  |  |
| Pets should be given alternative illness.   | water. Contact a veterin   | arian immediately if  | pets or livestock show signs of  |
| <b>Do not boil the water.</b> Boiling concentrated as a result of boili   | •  | / microcystins and i  | t may become more  |
| What happened? What is bein   | g done?  |   |  |
| , a source<br>bloom (HAB). We are working of<br>situation. We are making adjust<br>continue to sample our water. V<br>about HABs can be found at epa                                      | closely with local and stat<br>ments to our treatment p<br>We will keep you informed | e public health age<br>processes to reduce<br>d as the situation is | microcystins and we will resolved. Additional information                                      |
| For more information, please co   | ntact  | at  | ·  |
| Please share this information and notice directly (for example, peoposting this notice in a public pla  | ole in apartments, nursing   | n homes, schools and  |  |
| This notice is sent to you by   |  | system on/_   | _/   |

### **Appendix F—Lab Lists**

#### **EPA Approved Labs for UCMR4 Cyanotoxins**

Full list at <u>epa.gov/dwucmr/list-laboratories-approved-epa-fourth-unregulated-contaminant-monitoring-rule-ucmr-4</u>.

The following table lists in-state UCMR4 approved labs.

| Approved Labs                | Location    | Phone          | EPA<br>Method<br>544 <sup>1</sup> | EPA<br>Method<br>545 <sup>2</sup> | EPA<br>Method<br>546 <sup>3</sup> |
|------------------------------|-------------|----------------|-----------------------------------|-----------------------------------|-----------------------------------|
| King County<br>Environmental | Seattle, WA | (206) 477-7117 | Yes                               | Yes                               | Yes                               |
| Water Management             | Tacoma, WA  | (253) 531-3121 | -                                 | Yes                               | Yes                               |

Labs approved for Cyanotoxin analysis by Ecology lab certification program

| Approved Labs                     | Location     | Phone          | EPA<br>Method<br>544 <sup>1</sup> | EPA<br>Method<br>545 <sup>2</sup> | EPA<br>Method<br>546 <sup>3</sup> |
|-----------------------------------|--------------|----------------|-----------------------------------|-----------------------------------|-----------------------------------|
| King County<br>Environmental      | Seattle, WA  | (206) 477-7117 | Yes                               | Yes                               | Yes                               |
| Eurofins Eaton<br>Analytical, LLC | Monrovia, CA | (626) 386-1170 | -                                 | Yes                               | Yes                               |

Source: apps.ecology.wa.gov/laboratorysearch.

EPA Approved Lab Methods for Cyanotoxins:

- 1. EPA Method 544: Microcystin-LA, Microcystin-RR, Microcystin-LF, Microcystin-YR, Microcystin-LR, Microcystin-LY, Nodularin (LC/MS/MS).
- 2. EPA Method 545: Cylindrospermopsin, Anatoxin-a (LC/ESI-MS/MS)
- 3. EPA Method 546: Total Microcystins (ELISA).

#### Labs for Cyanobacteria identification and enumeration only

Note: In addition to the following, labs listed above can also identify and enumerate freshwater phytoplankton.

| Lab Name  | Address  | Phone                    |
|---|--|--------------------------|
| Advanced Eco-Solutions, Inc.  | 1324 N Liberty Lake Rd, #124                   | (509) 226-0146           |
| Darren.brandt@adveco-sol.com  | Liberty Lake, WA 99019                         | (208) 660-8733           |
| Aquatic Analysts Jim Sweet jwsweet@aol.com www.AAalgae.com  | 43 Telegraph Ln<br>Friday Harbor, WA 98250     | (503) 869-5032           |
| EcoAnalysts  www.ecoanalysts.com  also provide chlorophyll and phycocyanin analysis (EPA methods 445 and 446) | 1420 S Blaine St, Suite 14<br>Moscow, ID 83843 | (208) 882-2588<br>Ext 21 |

Source: <u>epa.gov/cyanohabs/laboratories-analyze-cyanobacteria-and-cyanotoxins#washington</u>.

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#### **Other Resources**

AWWA CyanoTOX Spreadsheet for Cyanotoxin Removal Rate Calculation. <u>awwa.org/Resources-Tools/Resources/Cyanotoxins.</u>

CDC, (no date). Physician Reference: Cyanobacteria blooms. "When in doubt, it's best to stay out!" Publication #CS258192. <a href="mailto:cdc.gov/habs/pdf/habsphysician\_card.pdf">cdc.gov/habs/pdf/habsphysician\_card.pdf</a>.

EPA Small Systems Webinar, "Responding to Harmful Algal Blooms, Optimization Guidelines and Sampling for Utilities," Recorded webinar online at: <a href="mailto:youtube.com/watch?v=ZRCrxGfDMuo&feature=youtu.be">youtube.com/watch?v=ZRCrxGfDMuo&feature=youtu.be</a>.

Hayden, A., et.al. (2020), A Tale of Two Utilities: Cyanotoxin Response Plans. J Am Water Works Assoc, <a href="https://awwa.onlinelibrary.wiley.com/doi/abs/10.1002/awwa.1592">awwa.onlinelibrary.wiley.com/doi/abs/10.1002/awwa.1592</a>

Ohio EPA, 2016. Generalized Cyanotoxin Treatment Optimization Recommendations. Available online at: epa.ohio.gov/Portals/28/documents/habs/Generalized%20Cyanotoxin%20Treatment%20Optimization%20R ecommendations.pdf.

Ohio EPA Harmful Algal Blooms webpage: epa.ohio.gov/ddagw/HAB.aspx.

Oregon Health Authority, Harmful Algal Blooms Resources for Operators: webpage <a href="https://oregon.gov/oha/PH/HealthyEnvironments/DrinkingWater/Operations/Treatment/Pages/algae.aspx">oregon.gov/oha/PH/HealthyEnvironments/DrinkingWater/Operations/Treatment/Pages/algae.aspx</a>.

USEPA. 2016. Harmful Algal Blooms and Drinking Water: <u>epa.gov/sites/production/files/2016-11/documents/harmful\_algal\_blooms\_and\_drinking\_water\_factsheet.pdf</u>.

USEPA. 2015. Current Water Treatment and Distribution System Optimization for Cyanotoxins. Recorded webinar online at: <a href="mailto:capcertconnections.files.wordpress.com/2015/05/ord-smallsystems-webinar-may2015.pdf">capcertconnections.files.wordpress.com/2015/05/ord-smallsystems-webinar-may2015.pdf</a>.

USEPA. 2014. Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems. EPA-810F11001. Retrieved online May 28, 2020, at: <a href="mailto:epa.gov/sites/production/files/2014-08/documents/cyanobacteria">epa.gov/sites/production/files/2014-08/documents/cyanobacteria</a> factsheet.pdf.

USGS. 2015. Field and Laboratory Guide to Freshwater Cyanobacteria Harmful Algal Blooms for Native American and Alaska Native Communities. <a href="mailto:pubs.usgs.gov/of/2015/1164/ofr20151164.pdf">pubs.usgs.gov/of/2015/1164/ofr20151164.pdf</a>.

WDOH. 2007. <u>Toxic Blue-Green Algae Blooms 334-136</u>, Washington State Department of Health, Olympia, WA.

WDOH. 2015. <u>Water System Guidance for Harmful Algal Blooms 331-531</u>, Washington State Department of Health, Olympia, WA.